

Progress: its law and cause

Spencer, Herbert

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PROGRESS: ITS LAW AND CAUSE.

[First published in The Westminster Review for April, 1857. Though the ideas and illustrations contained in this essay were eventually incorporated in First Principles, yet I think it well here to reproduce it as exhibiting the form under which the General Doctrine of Evolution made its first appearance.]

THE current conception of progress is shifting and indefinite. Sometimes it comprehends little more than simple growth—as of a nation in the number of its members and the extent of territory over which it spreads. Sometimes it has reference to quantity of material products—as when the advance of agriculture and manufactures is the topic. Sometimes the superior quality of these products is contemplated; and sometimes the new or improved appliances by which they are produced. When, again, we speak of moral or intellectual progress, we refer to states of the individual or people exhibiting it; while, when the progress of Science, or Art, is commented upon, we have in view certain abstract results of human thought and action. Not only, however, is the current conception of progress more or less vague, but it is in great measure erroneous. It takes in not so much the reality of progress as its accompaniments—not so much the substance as the shadow. That progress in intelligence seen during the growth of the child into the man, or the savage into the philosopher, is commonly regarded as consisting in the greater number

of facts known and laws understood; whereas the actual progress consists in those internal modifications of which this larger knowledge is the expression. Social progress is supposed to consist in the making of a greater quantity and variety of the articles required for satisfying men's wants; in the increasing security of person and property; in widening freedom of action; whereas, rightly understood, social progress consists in those changes of structure in the social organism which have entailed these consequences. The current conception is a teleological one. The phenomena are contemplated solely as bearing on human happiness. Only those changes are held to constitute progress which directly or indirectly tend to heighten human happiness; and they are thought to constitute progress simply *because* they tend to heighten human happiness. But rightly to understand progress, we must learn the nature of these changes, considered apart from our interests. Ceasing, for example, to regard the successive geological modifications that have taken place in the Earth, as modifications that have gradually fitted it for the habitation of Man, and as *therefore* constituting geological progress, we must ascertain the character common to these modifications—the law to which they all conform. And similarly in every other case. Leaving out of sight concomitants and beneficial consequences, let us ask what progress is in itself.

In respect to that progress which individual organisms display in the course of their evolution, this question has been answered by the Germans. The investigations of Wolff, Goethe, and von Baer, have established the truth that the series of changes gone through during the development of a seed into a tree, or an ovum into an animal, constitute an advance from homogeneity of structure to heterogeneity of structure. In its primary stage, every germ consists of a substance that is uniform throughout, both in texture and chemical composition. The first step

is the appearance of a difference between two parts of this substance; or, as the phenomenon is called in physiological language, a differentiation. Each of these differentiated divisions presently begins itself to exhibit some contrast of parts: and by and by these secondary differentiations become as definite as the original one. This process is continuously repeated—is simultaneously going on in all parts of the growing embryo; and by endless such differentiations there is finally produced that complex combination of tissues and organs constituting the adult animal or plant. This is the history of all organisms whatever. It is settled beyond dispute that organic progress consists in a change from the homogeneous to the heterogeneous.

Now, we propose in the first place to show, that this law of organic progress is the law of all progress. Whether it be in the development of the Earth, in the development of Life upon its surface, in the development of Society, of Government, of Manufactures, of Commerce, of Language, Literature, Science, Art, this same evolution of the simple into the complex, through successive differentiations, holds throughout. From the earliest traceable cosmical changes down to the latest results of civilization, we shall find that the transformation of the homogeneous into the heterogeneous, is that in which progress essentially consists.

With the view of showing that *if* the Nebular Hypothesis be true, the genesis of the solar system supplies one illustration of this law, let us assume that the matter of which the sun and planets consist was once in a diffused form; and that from the gravitation of its atoms there resulted a gradual concentration. By the hypothesis, the solar system in its nascent state existed as an indefinitely extended and nearly homogeneous medium—a medium almost homogeneous in density, in temperature, and in other physical attributes. The first change in the direction of increased aggregation, brought a contrast in density and a contrast in temperature, between the interior and the exterior

of this mass. Simultaneously the drawing in of outer parts caused motions ending in rotation round a centre with various angular velocities. These differentiations increased in number and degree until there was evolved the organized group of sun, planets, and satellites, which we now know—a group which presents numerous contrasts of structure and action among its members. There are the immense contrasts between the sun and the planets, in bulk and in weight; as well as the subordinate contrasts between one planet and another, and between the planets and their satellites. There is the similarly-marked contrast between the sun as almost stationary (relatively to the other members of the Solar System), and the planets as moving round him with great velocity : while there are the secondary contrasts between the velocities and periods of the several planets, and between their simple revolutions and the double ones of their satellites, which have to move round their primaries while moving round the sun. There is the yet further strong contrast between the sun and the planets in respect of temperature; and there is good reason to suppose that the planets and satellites differ from each other in their proper heats, as well as in the amounts of heat they receive from the sun. When we bear in mind that, in addition to these various contrasts, the planets and satellites also differ in respect to their distances from each other and their primary; in respect to the inclinations of their orbits, the inclinations of their axes, their times of rotation on their axes, their specific gravities, and their physical constitutions; we see what a high degree of heterogeneity the solar system exhibits, when compared with the almost complete homogeneity of the nebulous mass out of which it is supposed to have originated.

Passing from this hypothetical illustration, which must be taken for what it is worth, without prejudice to the general argument, let us descend to a more certain order of evidence. It is now generally agreed among geologists

and physicists that the Earth was at one time a mass of molten matter. If so, it was at that time relatively homogeneous in consistence, and, in virtue of the circulation which takes place in heated fluids, must have been comparatively homogeneous in temperature; and it must have been surrounded by an atmosphere consisting partly of the elements of air and water, and partly of those various other elements which are among the more ready to assume gaseous forms at high temperatures. That slow cooling by radiation which is still going on at an inappreciable rate, and which, though originally far more rapid than now, necessarily required an immense time to produce any decided change, must ultimately have resulted in the solidification of the portion most able to part with its heat—namely, the surface. In the thin crust thus formed we have the first marked differentiation. A still further cooling, a consequent thickening of this crust, and an accompanying deposition of all solidifiable elements contained in the atmosphere, must finally have been followed by the condensation of the water previously existing as vapour. A second marked differentiation must thus have arisen; and as the condensation must have taken place on the coolest parts of the surface—namely, about the poles—there must thus have resulted the first geographical distinction of parts. To these illustrations of growing heterogeneity, which, though deduced from known physical laws, may be regarded as more or less hypothetical, Geology adds an extensive series that have been inductively established. Investigations show that the Earth has been continually becoming more heterogeneous in virtue of the multiplication of sedimentary strata which form its crust; also, that it has been becoming more heterogeneous in respect of the composition of these strata, the later of which, being made from the detritus of the earlier, are many of them rendered highly complex by the mixture of materials they contain; and further, that this heterogeneity

has been vastly increased by the actions of the Earth's still molten nucleus upon its envelope, whence have resulted not only many kinds of igneous rocks, but the tilting up of sedimentary strata at all angles, the formation of faults and metallic veins, the production of endless dislocations and irregularities. Yet again, geologists teach us that the Earth's surface has been growing more varied in elevation—that the most ancient mountain systems are the smallest, and the Andes and Himalayas the most modern; while in all probability there have been corresponding changes in the bed of the ocean. As a consequence of these ceaseless differentiations, we now find that no considerable portion of the Earth's exposed surface is like any other portion, either in contour, in geologic structure, or in chemical composition; and that in most parts it changes from mile to mile in all these characters. Moreover, there has been simultaneously going on a differentiation of climates. As fast as the Earth cooled and its crust solidified, there arose appreciable differences in temperature between those parts of its surface more exposed to the sun and those less exposed. As the cooling progressed, these differences became more pronounced; until there finally resulted those marked contrasts between regions of perpetual ice and snow, regions where winter and summer alternately reign for periods varying according to the latitude, and regions where summer follows summer with scarcely an appreciable variation. At the same time the many and varied elevations and subsidences of portions of the Earth's crust, bringing about the present irregular distribution of land and sea, have entailed modifications of climate beyond those dependent on latitude; while a yet further series of such modifications have been produced by increasing differences of elevation in the land, which have in sundry places brought arctic, temperate, and tropical climates to within a few miles of one another. And the general outcome of these changes is, that not only has every extensive region

its own meteorologic conditions, but that every locality in each region differs more or less from others in those conditions; as in its structure, its contour, its soil. Thus, between our existing Earth, the phenomena of whose crust neither geographers, geologists, mineralogists, nor meteorologists have yet enumerated, and the molten globe out of which it was evolved, the contrast in heterogeneity is extreme.

When from the Earth itself we turn to the plants and animals which have lived, or still live, upon its surface, we find ourselves in some difficulty from lack of facts. That every existing organism has been developed out of the simple into the complex, is indeed the first established truth of all; and that every organism which existed in past times was similarly developed, is an inference no physiologist will hesitate to draw. But when we pass from individual forms of life to Life in general, and inquire whether the same law is seen in the *ensemble* of its manifestations,—whether modern plants and animals are of more heterogeneous structure than ancient ones, and whether the Earth's present Flora and Fauna are more heterogeneous than the Flora and Fauna of the past,—we find the evidence so fragmentary, that every conclusion is open to dispute. Three-fifths of the Earth's surface being covered by water; a great part of the exposed land being inaccessible to, or untravelled by, the geologist; the greater part of the remainder having been scarcely more than glanced at; and even the most familiar portions, as England, having been so imperfectly explored that a new series of strata has been added within these four years,—it is impossible for us to say with certainty what creatures have, and what have not, existed at any particular period. Considering the perishable nature of many of the lower organic forms, the metamorphosis of numerous sedimentary strata, and the great gaps occurring among the rest, we shall see further reason for distrusting our deductions. On the

one hand, the repeated discovery of vertebrate remains in strata previously supposed to contain none,—of reptiles where only fish were thought to exist,—of mammals where it was believed there were no creatures higher than reptiles,—renders it daily more manifest how small is the value of negative evidence. On the other hand, the worthlessness of the assumption that we have discovered the earliest, or anything like the earliest, organic remains, is becoming equally clear. That the oldest known sedimentary rocks have been greatly changed by igneous action, and that still older ones have been totally transformed by it, is becoming undeniable. And the fact that sedimentary strata earlier than any we know, have been melted up, being admitted, it must also be admitted that we cannot say how far back in time this destruction of sedimentary strata has been going on. Thus the title *Palæozoic*, as applied to the earliest known fossiliferous strata, involves a *petitio principii*; and, for aught we know to the contrary, only the last few chapters of the Earth's biological history may have come down to us. On neither side, therefore, is the evidence conclusive. Nevertheless we cannot but think that, scanty as they are, the facts, taken altogether, tend to show both that the more heterogeneous organisms have been evolved in the later geologic periods, and that Life in general has been more heterogeneously manifested as time has advanced. Let us cite, in illustration, the one case of the *Vertebrata*. The earliest known vertebrate remains are those of Fishes; and Fishes are the most homogeneous of the vertebrata. Later and more heterogeneous are Reptiles. Later still, and more heterogeneous still, are Birds and Mammals. If it be said that the Palæozoic deposits, not being estuary deposits, are not likely to contain the remains of terrestrial vertebrata, which may nevertheless have existed at that era, we reply that we are merely pointing to the leading facts, *such as they are*. But to avoid any such criticism, let us take the mammalian sub-

division only. The earliest known remains of mammals are those of small marsupials, which are the lowest of the mammalian type; while, conversely, the highest of the mammalian type—Man—is the most recent. The evidence that the vertebrate fauna, as a whole, has become more heterogeneous, is considerably stronger. To the argument that the vertebrate fauna of the Palæozoic period, consisting, so far as we know, entirely of Fishes, was less heterogeneous than the modern vertebrate fauna, which includes Reptiles, Birds, and Mammals, of multitudinous genera, it may be replied, as before, that estuary deposits of the Palæozoic period, could we find them, might contain other orders of vertebrata. But no such reply can be made to the argument that whereas the marine vertebrata of the Palæozoic period consisted entirely of cartilaginous fishes, the marine vertebrata of later periods include numerous genera of osseous fishes; and that, therefore, the later marine vertebrate faunas are more heterogeneous than the oldest known one. Nor, again, can any such reply be made to the fact that there are far more numerous orders and genera of mammalian remains in the tertiary formations than in the secondary formations. Did we wish merely to make out the best case, we might dwell upon the opinion of Dr. Carpenter, who says that “the general facts of Palæontology appear to sanction the belief, that *the same plan* may be traced out in what may be called *the general life of the globe*, as in *the individual life* of every one of the forms of organized being which now people it.” Or we might quote, as decisive, the judgment of Professor Owen, who holds that the earlier examples of each group of creatures severally departed less widely from archetypal generality than the later examples—were severally less unlike the fundamental form common to the group as a whole; and thus constituted a less heterogeneous group of creatures. But in deference to an authority for whom we have the highest respect, who considers that the

evidence at present obtained does not justify a verdict either way, we are content to leave the question open.*

Whether an advance from the homogeneous to the heterogeneous is or is not displayed in the biological history of the globe, it is clearly enough displayed in the progress of the latest and most heterogeneous creature—Man. It is true alike that, during the period in which the Earth has been peopled, the human organism has grown more heterogeneous among the civilized divisions of the species; and that the species, as a whole, has been growing more heterogeneous in virtue of the multiplication of races and the differentiation of these races from each other. In proof of the first of these positions, we may cite the fact that, in the relative development of the limbs, the civilized man departs more widely from the general type of the placental mammalia than do the lower human races. While often possessing well-developed body and arms, the Australian has very small legs: thus reminding us of the chimpanzee and the gorilla, which present no great contrasts in size between the hind and fore limbs. But in the European, the greater length and massiveness of the legs have become marked—the fore and hind limbs are more heterogeneous. Again, the greater ratio which the cranial bones bear to the facial bones illustrates the same truth. Among the vertebrata in general, progress is marked by an increasing heterogeneity in the vertebral column, and more especially in the segments constituting the skull: the higher forms being distinguished by the relatively larger size of the bones which cover the brain, and the relatively

* Since this was written (in 1857) the advance of paleontological discovery, especially in America, has shown conclusively, in respect of certain groups of vertebrates, that higher types have arisen by modifications of lower; so that, in common with others, Prof. Huxley, to whom the above allusion is made, now admits, or rather asserts, biological progression, and, by implication, that there have arisen more heterogeneous organic forms and a more heterogeneous assemblage of organic forms.

smaller size of those which form the jaws, &c. Now this characteristic, which is stronger in Man than in any other creature, is stronger in the European than in the savage. Moreover, judging from the greater extent and variety of faculty he exhibits, we may infer that the civilized man has also a more complex or heterogeneous nervous system than the uncivilized man : and, indeed, the fact is in part visible in the increased ratio which his cerebrum bears to the subjacent ganglia, as well as in the wider departure from symmetry in its convolutions. If further elucidation be needed, we may find it in every nursery. The infant European has sundry marked points of resemblance to the lower human races ; as in the flatness of the alæ of the nose, the depression of its bridge, the divergence and forward opening of the nostrils, the form of the lips, the absence of a frontal sinus, the width between the eyes, the smallness of the legs. Now, as the developmental process by which these traits are turned into those of the adult European, is a continuation of that change from the homogeneous to the heterogeneous displayed during the previous evolution of the embryo, which every anatomist will admit ; it follows that the parallel developmental process by which the like traits of the barbarous races have been turned into those of the civilized races, has also been a continuation of the change from the homogeneous to the heterogeneous. The truth of the second position—that Mankind, as a whole, have become more heterogeneous—is so obvious as scarcely to need illustration. Every work on Ethnology, by its divisions and subdivisions of races, bears testimony to it. Even were we to admit the hypothesis that Mankind originated from several separate stocks, it would still remain true, that as, from each of these stocks, there have sprung many now widely-different tribes, which are proved by philological evidence to have had a common origin, the race as a whole is far less homogeneous than it once was. Add to which, that we have, in the Anglo-

Americans, an example of a new variety arising within these few generations ; and that, if we may trust to the descriptions of observers, we are likely soon to have another such example in Australia.

On passing from Humanity under its individual form, to Humanity as socially embodied, we find the general law still more variously exemplified. The change from the homogeneous to the heterogeneous is displayed in the progress of civilization as a whole, as well as in the progress of every nation ; and is still going on with increasing rapidity. As we see in existing barbarous tribes, society in its first and lowest form is a homogeneous aggregation of individuals having like powers and like functions : the only marked difference of function being that which accompanies difference of sex. Every man is warrior, hunter, fisherman, tool-maker, builder ; every woman performs the same drudgeries. Very early, however, in the course of social evolution, there arises an incipient differentiation between the governing and the governed. Some kind of chieftainship seems coeval with the first advance from the state of separate wandering families to that of a nomadic tribe. The authority of the strongest or the most cunning makes itself felt among a body of savages as in a herd of animals, or a posse of schoolboys. At first, however, it is indefinite, uncertain ; is shared by others of scarcely inferior power ; and is unaccompanied by any difference in occupation or style of living : the first ruler kills his own game, makes his own weapons, builds his own hut, and, economically considered, does not differ from others of his tribe. Gradually, as the tribe progresses, the contrast between the governing and the governed grows more decided. Supreme power becomes hereditary in one family ; the head of that family, ceasing to provide for his own wants, is served by others ; and he begins to assume the sole office of ruling. At the same time there has been arising a co-ordinate species of

government—that of Religion. As all ancient records and traditions prove, the earliest rulers are regarded as divine personages. The maxims and commands they uttered during their lives are held sacred after their deaths, and are enforced by their divinely-descended successors; who in their turns are promoted to the pantheon of the race, here to be worshipped and propitiated along with their predecessors: the most ancient of whom is the supreme god, and the rest subordinate gods. For a long time these connate forms of government—civil and religious—remain closely associated. For many generations the king continues to be the chief priest, and the priesthood to be members of the royal race. For many ages religious law continues to include more or less of civil regulation, and civil law to possess more or less of religious sanction; and even among the most advanced nations these two controlling agencies are by no means completely separated from each other. Having a common root with these, and gradually diverging from them, we find yet another controlling agency—that of Ceremonial usages. All titles of honour are originally the names of the god-king; afterwards of the god and the king; still later of persons of high rank; and finally come, some of them, to be used between man and man. All forms of complimentary address were at first the expressions of submission from prisoners to their conqueror, or from subjects to their ruler, either human or divine—expressions which were afterwards used to propitiate subordinate authorities, and slowly descended into ordinary intercourse. All modes of salutation were once obeisances made before the monarch and used in worship of him after his death. Presently others of the god-descended race were similarly saluted; and by degrees some of the salutations have become the due of all.* Thus, no sooner does the originally-homogeneous social mass differentiate

* For detailed proof of these assertions see essay on "Manners and Fashion."

into the governed and the governing parts, than this last exhibits an incipient differentiation into religious and secular—Church and State; while at the same time there begins to be differentiated from both, that less definite species of government which rules our daily intercourse—a species of government which, as we may see in heralds' colleges, in books of the peerage, in masters of ceremonies, is not without a certain embodiment of its own. Each of these is itself subject to successive differentiations. In the course of ages, there arises, as among ourselves, a highly complex political organization of monarch, ministers, lords and commons, with their subordinate administrative departments, courts of justice, revenue offices, &c., supplemented in the provinces by municipal governments, county governments, parish or union governments—all of them more or less elaborated. By its side there grows up a highly complex religious organization, with its various grades of officials, from archbishops down to sextons, its colleges, convocations, ecclesiastical courts, &c.; to all which must be added the ever-multiplying independent sects, each with its general and local authorities. And at the same time there is developed a highly complex aggregation of customs, manners, and temporary fashions, enforced by society at large, and serving to control those minor transactions between man and man which are not regulated by civil and religious law. Moreover, it is to be observed that this increasing heterogeneity in the governmental appliances of each nation, has been accompanied by an increasing heterogeneity in the assemblage of governmental appliances of different nations: all nations being more or less unlike in their political systems and legislation, in their creeds and religious institutions, in their customs and ceremonial usages.

Simultaneously there has been going on a second differentiation of a more familiar kind; that, namely, by which the mass of the community has been segregated into distinct classes and orders of workers. While the

governing part has undergone the complex development above detailed, the governed part has undergone an equally complex development, which has resulted in that minute division of labour characterizing advanced nations. It is needless to trace out this progress from its first stages, up through the caste-divisions of the East and the incorporated guilds of Europe, to the elaborate producing and distributing organization existing among ourselves. It has been an evolution which, beginning with a tribe whose members severally perform the same actions each for himself, ends with a civilized community whose members severally perform different actions for each other ; and an evolution which has transformed the solitary producer of any one commodity into a combination of producers who, united under a master, take separate parts in the manufacture of such commodity. But there are yet other and higher phases of this advance from the homogeneous to the heterogeneous in the industrial organization of society. Long after considerable progress has been made in the division of labour among different classes of workers, there is still little or no division of labour among the widely separated parts of the community : the nation continues comparatively homogeneous in the respect that in each district the same occupations are pursued. But when roads and other means of transit become numerous and good, the different districts begin to assume different functions, and to become mutually dependent. The calico manufacture locates itself in this county, the woollen-cloth manufacture in that ; silks are produced here, lace there ; stockings in one place, shoes in another ; pottery, hardware, cutlery, come to have their special towns ; and ultimately every locality becomes more or less distinguished from the rest by the leading occupation carried on in it. This subdivision of functions shows itself not only among the different parts of the same nation, but among different nations. That exchange of commodities which free-trade is increasing

so largely, will ultimately have the effect of specializing, in a greater or less degree, the industry of each people. So that, beginning with a barbarous tribe, almost if not quite homogeneous in the functions of its members, the progress has been, and still is, towards an economic aggregation of the whole human race; growing ever more heterogeneous in respect of the separate functions assumed by separate nations, the separate functions assumed by the local sections of each nation, the separate functions assumed by the many kinds of makers and traders in each town, and the separate functions assumed by the workers united in producing each commodity.

The law thus clearly exemplified in the evolution of the social organism, is exemplified with equal clearness in the evolution of all products of human thought and action; whether concrete or abstract, real or ideal. Let us take Language as our first illustration.

The lowest form of language is the exclamation, by which an entire idea is vaguely conveyed through a single sound, as among the lower animals. That human language ever consisted solely of exclamations, and so was strictly homogeneous in respect of its parts of speech, we have no evidence. But that language can be traced down to a form in which nouns and verbs are its only elements, is an established fact. In the gradual multiplication of parts of speech out of these primary ones—in the differentiation of verbs into active and passive, of nouns into abstract and concrete—in the rise of distinctions of mood, tense, person, of number and case—in the formation of auxiliary verbs, of adjectives, adverbs, pronouns, prepositions, articles—in the divergence of those orders, genera, species, and varieties of parts of speech by which civilized races express minute modifications of meaning—we see a change from the homogeneous to the heterogeneous. Another aspect under which we may trace the development of language is the divergence of words having common origins. Philology

early disclosed the truth that in all languages words may be grouped into families, the members of each of which are allied by their derivation. Names springing from a primitive root, themselves become the parents of other names still further modified. And by the aid of those systematic modes which presently arise, of making derivatives and forming compound terms, there is finally developed a tribe of words so heterogeneous in sound and meaning, that to the uninitiated it seems incredible they should be nearly related. Meanwhile from other roots there are being evolved other such tribes, until there results a language of some sixty thousand or more unlike words, signifying as many unlike objects, qualities, acts. Yet another way in which language in general advances from the homogeneous to the heterogeneous, is in the multiplication of languages. Whether all languages have grown from one stock, or whether, as some philologists think, they have grown from two or more stocks, it is clear that since large groups of languages, as the Indo-European, are of one parentage, they have become distinct through a process of continuous divergence. The same diffusion over the Earth's surface which has led to differentiations of race, has simultaneously led to differentiations of speech: a truth which we see further illustrated in each nation by the distinct dialects found in separate districts. Thus the progress of Language conforms to the general law, alike in the evolution of languages, in the evolution of families of words, and in the evolution of parts of speech.

On passing from spoken to written language, we come upon several classes of facts, having similar implications. Written language is connate with Painting and Sculpture; and at first all three are appendages of Architecture, and have a direct connection with the primary form of all Government—the theocratic. Merely noting by the way the fact that sundry wild races, as for example the Austrians and the tribes of South Africa, are given to depicting

personages and events upon the walls of caves, which are probably regarded as sacred places, let us pass to the case of the Egyptians. Among them, as also among the Assyrians, we find mural paintings used to decorate the temple of the god and the palace of the king (which were, indeed, originally identical) ; and as such they were governmental appliances in the same sense as state-pageants and religious feasts were. They were governmental appliances in another way : representing as they did the worship of the god, the triumphs of the god-king, the submission of his subjects, and the punishment of the rebellious. Further, they were governmental, as being the products of an art revered by the people as a sacred mystery. From the habitual use of this pictorial representation there grew up the but-slightly-modified practice of picture-writing—a practice which was found still extant among North American peoples at the time they were discovered. By abbreviations analogous to those still going on in our own written language, the most frequently-recurring of these pictured figures were successively simplified ; and ultimately there grew up a system of symbols, most of which had but distant resemblances to the things for which they stood. The inference that the hieroglyphics of the Egyptians were thus produced, is confirmed by the fact that the picture-writing of the Mexicans was found to have given birth to a like family of ideographic forms ; and among them, as among the Egyptians, these had been partially differentiated into the *kuriological* or imitative, and the *tropical* or symbolic ; which were, however, used together in the same record. In Egypt, written language underwent a further differentiation, whence resulted the *hieratic* and the *epistolographic* or *enchorial* ; both of which are derived from the original hieroglyphic. At the same time we find that for the expression of proper names, which could not be otherwise conveyed, signs having phonetic values were employed ; and though it is alleged that the Egyptians

never achieved complete alphabetic writing, yet it can scarcely be doubted that these phonetic symbols, occasionally used in aid of their ideographic ones, were the germs of an alphabetic system. Once having become separate from hieroglyphics, alphabetic writing itself underwent numerous differentiations — multiplied alphabets were produced; between most of which, however, more or less connection can still be traced. And in each civilized nation there has now grown up, for the representation of one set of sounds, several sets of written signs used for distinct purposes. Finally, from writing diverged printing; which, uniform in kind as it was at first, has since become multiform.

While written language was passing through its first stages of development, the mural decoration which contained its root was being differentiated into Painting and Sculpture. The gods, kings, men, and animals represented, were originally marked by indented outlines and coloured. In most cases these outlines were of such depth, and the object they circumscribed so far rounded and marked out in its leading parts, as to form a species of work intermediate between intaglio and bas-relief. In other cases we see an advance upon this: the raised spaces between the figures being chiselled off, and the figures themselves appropriately tinted, a painted bas-relief was produced. The restored Assyrian architecture at Sydenham exhibits this style of art carried to greater perfection—the persons and things represented, though still barbarously coloured, are carved out with more truth and in greater detail: and in the winged lions and bulls used for the angles of gateways, we may see a considerable advance towards a completely sculptured figure; which, nevertheless, is still coloured, and still forms part of the building. But while in Assyria the production of a statue proper seems to have been little, if at all, attempted, we may trace in Egyptian art the gradual separation of the sculptured figure from the wall. A walk through the collection in the British

Museum shows this; while at the same time it affords an opportunity of observing the traces which the independent statues bear of their derivation from bas-relief: seeing that nearly all of them not only display that fusion of the legs with one another and of the arms with the body which is characteristic of bas-relief, but have the back united from head to foot with a block which stands in place of the original wall. Greece repeated the leading stages of this progress. On the friezes of Greek Temples, were coloured bas-reliefs representing sacrifices, battles, processions, games—all in some sort religious. The pediments contained painted sculptures more or less united with the tympanum, and having for subjects the triumphs of gods or heroes. Even statues definitely separated from buildings were coloured; and only in the later periods of Greek civilization does the differentiation of Sculpture from Painting appear to have become complete. In Christian art we may trace a parallel re-genesis. All early works of art throughout Europe were religious in subject—represented Christs, crucifixions, virgins, holy families, apostles, saints. They formed integral parts of church architecture, and were among the means of exciting worship; as in Roman Catholic countries they still are. Moreover, the sculptured figures of Christ on the cross, of virgins, of saints, were coloured; and it needs but to call to mind the painted madonnas still abundant in continental churches and highways, to perceive the significant fact that Painting and Sculpture continue in closest connection with each other where they continue in closest connection with their parent. Even when Christian sculpture became differentiated from painting, it was still religious and governmental in its subjects—was used for tombs in churches and statues of kings; while, at the same time, painting, where not purely ecclesiastical, was applied to the decoration of palaces, and besides representing royal personages, was mostly devoted to sacred legends. Only in recent times

have painting and sculpture become quite separate and mainly secular. Only within these few centuries has Painting been divided into historical, landscape, marine, architectural, genre, animal, still-life, &c.; and Sculpture grown heterogeneous in respect of the variety of real and ideal subjects with which it occupies itself.

Strange as it seems then, we find that all forms of written language, of Painting, and of Sculpture, have a common root in the politico-religious decorations of ancient temples and palaces. Little resemblance as they now have, the landscape that hangs against the wall, and the copy of the *Times* lying on the table, are remotely akin. The brazen face of the knocker which the postman has just lifted, is related not only to the woodcuts of the *Illustrated London News* which he is delivering, but to the characters of the *billet-doux* which accompanies it. Between the painted window, the prayer-book on which its light falls, and the adjacent monument, there is consanguinity. The effigies on our coins, the signs over shops, the coat of arms outside the carriage panel, and the placards inside the omnibus, are, in common with dolls and paper-hangings, lineally descended from the rude sculpture-paintings in which ancient peoples represented the triumphs and worship of their god-kings. Perhaps no example can be given which more vividly illustrates the multiplicity and heterogeneity of the products that in course of time may arise by successive differentiations from a common stock.

Before passing to other classes of facts, it should be observed that the evolution of the homogeneous into the heterogeneous is displayed not only in the separation of Painting and Sculpture from Architecture and from each other, and in the greater variety of subjects they embody, but it is further shown in the structure of each work. A modern picture or statue is of far more heterogeneous nature than an ancient one. An Egyptian sculpture-fresco usually represents all its figures as at the same distance

from the eye ; and so is less heterogeneous than a painting that represents them as at various distances from the eye. It exhibits all objects as exposed to the same degree of light ; and so is less heterogeneous than a painting which exhibits its different objects and different parts of each object as in different degrees of light. It uses chiefly the primary colours, and these in their full intensities ; and so is less heterogeneous than a painting which, introducing the primary colours but sparingly, employs numerous intermediate tints, each of heterogeneous composition, and differing from the rest not only in quality but in strength. Moreover, we see in these early works great uniformity of conception. The same arrangement of figures is perpetually reproduced—the same actions, attitudes, faces, dresses. In Egypt the modes of representation were so fixed that it was sacrilege to introduce a novelty. The Assyrian bas-reliefs display parallel characters. Deities, kings, attendants, winged-figures and animals, are time after time depicted in like positions, holding like implements, doing like things, and with like expression or non-expression of face. If a palm-grove is introduced, all the trees are of the same height, have the same number of leaves, and are equidistant. When water is imitated, each wave is a counterpart of the rest ; and the fish, almost always of one kind, are evenly distributed over the surface. The beards of the kings, the gods, and the winged-figures, are everywhere similar ; as are the manes of the lions, and equally so those of the horses. Hair is represented throughout by one form of curl. The king's beard is quite architecturally built up of compound tiers of uniform curls, alternating with twisted tiers placed in a transverse direction, and arranged with perfect regularity ; and the terminal tufts of the bulls' tails are represented in exactly the same manner. Without tracing out analogous facts in early Christian art, in which, though less striking, they are still visible, the advance in heterogeneity will be sufficiently manifest on remembering

that in the pictures of our own day the composition is endlessly varied ; the attitudes, faces, expressions, unlike ; the subordinate objects different in sizes, forms, textures ; and more or less of contrast even in the smallest details. Or, if we compare an Egyptian statue, seated bolt upright on a block, with hands on knees, fingers parallel, eyes looking straight forward, and the two sides perfectly symmetrical in every particular, with a statue of the advanced Greek school or the modern school, which is asymmetrical in respect of the attitude of the head, the body, the limbs, the arrangement of the hair, dress, appendages, and in its relations to neighbouring objects, we shall see the change from the homogeneous to the heterogeneous clearly manifested.

In the co-ordinate origin and gradual differentiation of Poetry, Music, and Dancing, we have another series of illustrations. Rhythm in words, rhythm in sounds, and rhythm in motions, were in the beginning parts of the same thing, and have only in process of time become separate things. Among existing barbarous tribes we find them still united. The dances of savages are accompanied by some kind of monotonous chant, the clapping of hands, the striking of rude instruments : there are measured movements, measured words, and measured tones. The early records of historic races similarly show these three forms of metrical action united in religious festivals. In the Hebrew writings we read that the triumphal ode composed by Moses on the defeat of the Egyptians, was sung to an accompaniment of dancing and timbrels. The Israelites danced and sung "at the inauguration of the golden calf. And as it is generally agreed that this representation of the Deity was borrowed from the mysteries of Apis, it is probable that the dancing was copied from that of the Egyptians on those occasions." Again, in Greece the like relation is everywhere seen : the original type being there, as probably in other cases, a simultaneous chanting and mimetic representation of the life and adventures of the hero or the god.

The Spartan dances were accompanied by hymns and songs; and in general the Greeks had "no festivals or religious assemblies but what were accompanied with songs and dances"—both of them being forms of worship used before altars. Among the Romans, too, there were sacred dances: the Salian and Lupercalian being named as of that kind. And even in Christian countries, as at Limoges, in comparatively recent times, the people have danced in the choir in honour of a saint. The incipient separation of these once-united arts from each other and from religion, was early visible in Greece. Probably diverging from dances partly religious, partly warlike, as the Corybantian, came the war-dances proper, of which there were various kinds. Meanwhile Music and Poetry, though still united, came to have an existence separate from Dancing. The primitive Greek poems, religious in subject, were not recited but chanted; and though at first the chant of the poet was accompanied by the dance of the chorus, it ultimately grew into independence. Later still, when the poem had been differentiated into epic and lyric—when it became the custom to sing the lyric and recite the epic—poetry proper was born. As during the same period musical instruments were being multiplied, we may presume that music came to have an existence apart from words. And both of them were beginning to assume other forms besides the religious. Facts having like implications might be cited from the histories of later times and peoples; as the practices of our own early minstrels, who sang to the harp heroic narratives versified by themselves to music of their own composition: thus uniting the now separate offices of poet, composer, vocalist, and instrumentalist. But, without further illustration, the common origin and gradual differentiation of Dancing, Poetry, and Music will be sufficiently manifest.

The advance from the homogeneous to the heterogeneous is displayed not only in the separation of these arts from each other and from religion, but also in the multiplied

differentiations which each of them afterwards undergoes. Not to dwell upon the numberless kinds of dancing that have, in course of time, come into use: and not to occupy space in detailing the progress of poetry, as seen in the development of the various forms of metre, of rhyme, and of general organization; let us confine our attention to music as a type of the group. As implied by the customs of still extant barbarous races, the first musical instruments were, without doubt, percussive — sticks, calabashes, tom-toms—and were used simply to mark the time of the dance; and in this constant repetition of the same sound, we see music in its most homogeneous form. The Egyptians had a lyre with three strings. The early lyre of the Greeks had four, constituting their tetrachord. In course of some centuries lyres of seven and eight strings were employed; and, by the expiration of a thousand years, they had advanced to their “great system” of the double octave. Through all which changes there of course arose a greater heterogeneity of melody. Simultaneously there came into use the different modes—Dorian, Ionian, Phrygian, Æolian, and Lydian—answering to our keys; and of these there were ultimately fifteen. As yet, however, there was but little heterogeneity in the time of their music. Instrumental music being at first merely the accompaniment of vocal music, and vocal music being subordinated to words,—the singer being also the poet, chanting his own compositions and making the lengths of his notes agree with the feet of his verses,—there resulted a tiresome uniformity of measure, which, as Dr. Burney says, “no resources of melody could disguise.” Lacking the complex rhythm obtained by our equal bars and unequal notes, the only rhythm was that produced by the quantity of the syllables, and was of necessity comparatively monotonous. And further, it may be observed that the chant thus resulting, being like recitative, was much less clearly differentiated from ordinary speech than is our modern song. Never-

theless, in virtue of the extended range of notes in use, the variety of modes, the occasional variations of time consequent on changes of metre, and the multiplication of instruments, music had, towards the close of Greek civilization, attained to considerable heterogeneity—not indeed as compared with our music, but as compared with that which preceded it. Still, there existed nothing but melody: harmony was unknown. It was not until Christian church-music had reached some development, that music in parts was evolved; and then it came into existence through a very unobtrusive differentiation. Difficult as it may be to conceive *a priori* how the advance from melody to harmony could take place without a sudden leap, it is none the less true that it did so. The circumstance which prepared the way for it was the employment of two choirs singing alternately the same air. Afterwards it became the practice—very possibly first suggested by a mistake—for the second choir to commence before the first had ceased; thus producing a fugue. With the simple airs then in use, a partially-harmonious fugue might not improbably thus result: and a very partially-harmonious fugue satisfied the ears of that age, as we know from still preserved examples. The idea having once been given, the composing of airs productive of fugal harmony would naturally grow up, as in some way it *did* grow up, out of this alternate choir-singing. And from the fugue to concerted music of two, three, four, and more parts, the transition was easy. Without pointing out in detail the increasing complexity that resulted from introducing notes of various lengths, from the multiplication of keys, from the use of accidentals, from varieties of time, and so forth, it needs but to contrast music as it is, with music as it was, to see how immense is the increase of heterogeneity. We see this if, looking at music in its *ensemble*, we enumerate its many different genera and species—if we consider the divisions into vocal, instrumental, and mixed; and their subdivisions into music

for different voices and different instruments—if we observe the many forms of sacred music, from the simple hymn, the chant, the canon, motet, anthem, &c., up to the oratorio; and the still more numerous forms of secular music, from the ballad up to the serenata, from the instrumental solo up to the symphony. Again, the same truth is seen on comparing any one sample of aboriginal music with a sample of modern music—even an ordinary song for the piano; which we find to be relatively very heterogeneous, not only in respect of the variety in the pitches and in the lengths of the notes, the number of different notes sounding at the same instant in company with the voice, and the variations of strength with which they are sounded and sung, but in respect of the changes of key, the changes of time, the changes of *timbre* of the voice, and the many other modifications of expression. While between the old monotonous dance-chant and a grand opera of our own day, with its endless orchestral complexities and vocal combinations, the contrast in heterogeneity is so extreme that it seems scarcely credible that the one should have been the ancestor of the other.

Were they needed, many further illustrations might be cited. Going back to the early time when the deeds of the god-king were recorded in picture-writings on the walls of temples and palaces, and so constituted a rude literature, we might trace the development of Literature through phases in which, as in the Hebrew Scriptures, it presents in one work theology, cosmogony, history, biography, law, ethics, poetry; down to its present heterogeneous development, in which its separated divisions and subdivisions are so numerous and varied as to defy complete classification. Or we might trace out the evolution of Science; beginning with the era in which it was not yet differentiated from Art, and was, in union with Art, the handmaid of Religion; passing through the era in which the sciences were so few and rudimentary, as to be simultaneously cultivated by the same men; and ending with the era

in which the genera and species are so numerous that few can enumerate them, and no one can adequately grasp even one genus. Or we might do the like with Architecture, with the Drama, with Dress. But doubtless the reader is already weary of illustrations; and our promise has been amply fulfilled. Abundant proof has been given that the law of organic development formulated by von Baer, is the law of all development. The advance from the simple to the complex, through a process of successive differentiations, is seen alike in the earliest changes of the Universe to which we can reason our way back, and in the earliest changes which we can inductively establish; it is seen in the geologic and climatic evolution of the Earth; it is seen in the unfolding of every single organism on its surface, and in the multiplication of kinds of organisms; it is seen in the evolution of Humanity, whether contemplated in the civilized individual, or in the aggregate of races; it is seen in the evolution of Society in respect alike of its political, its religious, and its economical organization; and it is seen in the evolution of all those endless concrete and abstract products of human activity which constitute the environment of our daily life. From the remotest past which Science can fathom, up to the novelties of yesterday, that in which progress essentially consists, is the transformation of the homogeneous into the heterogeneous.

And now, must not this uniformity of procedure be a consequence of some fundamental necessity? May we not rationally seek for some all-pervading principle which determines this all-pervading process of things? Does not the universality of the *law* imply a universal *cause*?

That we can comprehend such cause, noumenally considered, is not to be supposed. To do this would be to solve that ultimate mystery which must ever transcend human intelligence. But it still may be possible for us to

reduce the law of all progress, above set forth, from the condition of an empirical generalization, to the condition of a rational generalization. Just as it was possible to interpret Kepler's laws as necessary consequences of the law of gravitation; so it may be possible to interpret this law of progress, in its multiform manifestations, as the necessary consequence of some similarly universal principle. As gravitation was assignable as the *cause* of each of the groups of phenomena which Kepler generalized; so may some equally simple attribute of things be assignable as the cause of each of the groups of phenomena generalized in the foregoing pages. We may be able to affiliate all these varied evolutions of the homogeneous into the heterogeneous, upon certain facts of immediate experience, which, in virtue of endless repetition, we regard as necessary.

The probability of a common cause, and the possibility of formulating it, being granted, it will be well, first, to ask what must be the general characteristics of such cause, and in what direction we ought to look for it. We can with certainty predict that it has a high degree of abstractness; seeing that it is common to such infinitely-varied phenomena. We need not expect to see in it an obvious solution of this or that form of progress; because it is equally concerned with forms of progress bearing little apparent resemblance to them: its association with multiform orders of facts, involves its dissociation from any particular order of facts. Being that which determines progress of every kind—astronomic, geologic, organic, ethnologic, social, economic, artistic, &c.—it must be involved with some fundamental trait displayed in common by these; and must be expressible in terms of this fundamental trait. The only obvious respect in which all kinds of progress are alike, is, that they are modes of *change*; and hence, in some characteristic of changes in general, the desired solution will probably be found. We may suspect *a priori* that in some universal law of change lies the

explanation of this universal transformation of the homogeneous into the heterogeneous.

Thus much premised, we pass at once to the statement of the law, which is this:—*Every active force produces more than one change—every cause produces more than one effect.*

To make this proposition comprehensible, a few examples must be given. When one body strikes another, that which we usually regard as the effect, is a change of position or motion in one or both bodies. But a moment's thought shows us that this is a very incomplete view of the matter. Besides the visible mechanical result, sound is produced; or, to speak accurately, a vibration in one or both bodies, which is communicated to the surrounding air; and under some circumstances we call this the effect. Moreover, the air has not only been made to undulate, but has had currents caused in it by the transit of the bodies. Further, there is a disarrangement of the particles of the two bodies in the neighbourhood of their point of collision; amounting, in some cases, to a visible condensation. Yet more, this condensation is accompanied by the disengagement of heat. In some cases a spark—that is, light—results, from the incandescence of a portion struck off; and sometimes this incandescence is associated with chemical combination. Thus, by the mechanical force expended in the collision, at least five, and often more, different kinds of changes have been produced. Take, again, the lighting of a candle. Primarily this is a chemical change consequent on a rise of temperature. The process of combination having once been started by extraneous heat, there is a continued formation of carbonic acid, water, &c.—in itself a result more complex than the extraneous heat that first caused it. But accompanying this process of combination there is a production of heat; there is a production of light; there is an ascending column of hot gases generated; there are inflowing currents set going in the surrounding air. Moreover, the complicating of effects does not end

here: each of the several changes produced becomes the parent of further changes. The carbonic acid given off will by and by combine with some base; or under the influence of sunshine give up its carbon to the leaf of a plant. The water will modify the hygrometric state of the air around; or, if the current of hot gases containing it comes against a cold body, will be condensed: altering the temperature of the surface it covers. The heat given out melts the subjacent tallow, and expands whatever it warms. The light, falling on various substances, calls forth from them reactions by which its composition is modified; and so divers colours are produced. Similarly even with these secondary actions, which may be traced out into ever-multiplying ramifications, until they become too minute to be appreciated. And thus it is with all changes whatever. No case can be named in which an active force does not evolve forces of several kinds, and each of these, other groups of forces. Universally the effect is more complex than the cause.

Doubtless the reader already foresees the course of our argument. This multiplication of effects, which is displayed in every event of to-day, has been going on from the beginning; and is true of the grandest phenomena of the universe as of the most insignificant. From the law that every active force produces more than one change, it is an inevitable corollary that during the past there has been an ever-growing complication of things. Throughout creation there must have gone on, and must still go on, a never-ceasing transformation of the homogeneous into the heterogeneous. Let us trace this truth in detail.

Without committing ourselves to it as more than a speculation, though a highly probable one, let us again commence with the evolution of the Solar System out of a nebulous medium. The hypothesis is that from the mutual attraction of the molecules of a diffused mass whose form is unsymmetrical, there results not only condensation but rotation. While the condensation and the rate of rotation

go on increasing, the approach of the molecules is necessarily accompanied by an increasing temperature. As the temperature rises, light begins to be evolved; and ultimately there results a revolving sphere of fluid matter radiating intense heat and light—a sun. There are reasons for believing that, in consequence of the higher tangential velocity originally possessed by the outer parts of the condensing nebulous mass, there will be occasional detachments of rotating rings; and that, from the breaking up of these nebulous rings, there will arise masses which in the course of their condensation repeat the actions of the parent mass, and so produce planets and their satellites—an inference strongly supported by the still extant rings of Saturn. Should it hereafter be satisfactorily shown that planets and satellites were thus generated, a striking illustration will be afforded of the highly heterogeneous effects produced by the primary homogeneous cause; but it will serve our present purpose to point to the fact that from the mutual attraction of the particles of an irregular nebulous mass there result condensation, rotation, heat, and light.

It follows as a corollary from the Nebular Hypothesis, that the Earth must once have been incandescent; and whether the Nebular Hypothesis be true or not, this original incandescence of the Earth is now inductively established—or, if not established, at least rendered so highly probable that it is an accepted geological doctrine. Let us look first at the astronomical attributes of this once molten globe. From its rotation there result the oblateness of its form, the alternations of day and night, and (under the influence of the moon and in a smaller degree the sun) the tides, aqueous and atmospheric. From the inclination of its axis, there result the many differences of the seasons, both simultaneous and successive, that pervade its surface, and from the same cause joined with the action of the moon on the equatorial protuberance there results the precession of the equinoxes. Thus the multiplication of

effects is obvious. Several of the differentiations due to the gradual cooling of the Earth have been already noticed—as the formation of a crust, the solidification of sublimed elements, the precipitation of water, &c.,—and we here again refer to them merely to point out that they are simultaneous effects of the one cause, diminishing heat. Let us now, however, observe the multiplied changes afterwards arising from the continuance of this one cause. The cooling of the Earth involves its contraction. Hence the solid crust first formed is presently too large for the shrinking nucleus; and as it cannot support itself, inevitably follows the nucleus. But a spheroidal envelope cannot sink down into contact with a smaller internal spheroid, without disruption: it must run into wrinkles as the rind of an apple does when the bulk of its interior decreases from evaporation. As the cooling progresses and the envelope thickens, the ridges consequent on these contractions will become greater, rising ultimately into hills and mountains; and the later systems of mountains thus produced will not only be higher, as we find them to be, but will be longer, as we also find them to be. Thus, leaving out of view other modifying forces, we see what immense heterogeneity of surface has arisen from the one cause, loss of heat—a heterogeneity which the telescope shows us to be paralleled on the face of Mars, and which in the moon too, where aqueous and atmospheric agencies have been absent, it reveals under a somewhat different form. But we have yet to notice another kind of heterogeneity of surface similarly and simultaneously caused. While the Earth's crust was still thin, the ridges produced by its contraction must not only have been small, but the spaces between these ridges must have rested with great evenness upon the subjacent liquid spheroid; and the water in those arctic and antarctic regions in which it first condensed, must have been evenly distributed. But as fast as the crust thickened and gained corresponding

strength, the lines of fracture from time to time caused in it, must have occurred at greater distances apart; the intermediate surfaces must have followed the contracting nucleus with less uniformity; and there must have resulted larger areas of land and water. If any one, after wrapping up an orange in tissue paper, and observing not only how small are the wrinkles, but how evenly the intervening spaces lie upon the surface of the orange, will then wrap it up in thick cartridge-paper, and note both the greater height of the ridges and the larger spaces throughout which the paper does not touch the orange, he will realize the fact that, as the Earth's solid envelope grew thicker, the areas of elevation and depression increased. In place of islands homogeneously dispersed amid an all-embracing sea, there must have gradually arisen heterogeneous arrangements of continent and ocean. Once more, this double change in the extent and in the elevation of the lands, involved yet another species of heterogeneity—that of coast-line. A tolerably even surface raised out of the ocean must have a simple, regular sea-margin; but a surface varied by table-lands and intersected by mountain-chains must, when raised out of the ocean, have an outline extremely irregular both in its leading features and in its details. Thus, multitudinous geological and geographical results are slowly brought about by this one cause—the contraction of the Earth.

When we pass from the agency termed igneous, to aqueous and atmospheric agencies, we see the like ever-growing complications of effects. The denuding actions of air and water, joined with those of changing temperature, have, from the beginning, been modifying every exposed surface. Oxidation, heat, wind, frost, rain, glaciers, rivers, tides, waves, have been unceasingly producing disintegration; varying in kind and amount according to local circumstances. Acting upon a tract of granite, they here work scarcely an appreciable effect; there cause exfoliations

of the surface, and a resulting heap of *débris* and boulders ; and elsewhere, after decomposing the feldspar into a white clay, carry away this and the accompanying quartz and mica, and deposit them in separate beds, fluvatile and marine. When the exposed land consists of several unlike kinds of sedimentary strata, or igneous rocks, or both, denudation produces changes proportionably more heterogeneous. The formations being disintegrable in different degrees, there follows an increased irregularity of surface. The areas drained by different rivers being differently constituted, these rivers carry down to the sea different combinations of ingredients ; and so sundry new strata of unlike compositions are formed. And here we may see very simply illustrated, the truth, which we shall presently have to trace out in more involved cases, that in proportion to the heterogeneity of the object or objects on which any force expends itself, is the heterogeneity of the effects. A continent of complex structure, exposing many strata irregularly distributed, raised to various levels, tilted up at all angles, will, under the same denuding agencies, give origin to innumerable and involved results : each district must be differently modified ; each river must carry down a different kind of detritus ; each deposit must be differently distributed by the entangled currents, tidal and other, which wash the contorted shores ; and this multiplication of results must manifestly be greatest where the complexity of surface is greatest.

Here we might show how the general truth, that every active force produces more than one change, is again exemplified in the highly-involved flow of the tides, in the ocean currents, in the winds, in the distribution of rain, in the distribution of heat, and so forth. But not to dwell upon these, let us, for the fuller elucidation of this truth in relation to the inorganic world, consider what would be the consequences of some extensive cosmical catastrophe—say the subsidence of Central America. The immediate results

of the disturbance would themselves be sufficiently complex. Besides the numberless dislocations of strata, the ejections of igneous matter, the propagation of earthquake vibrations thousands of miles around, the loud explosions, and the escape of gases; there would be the rush of the Atlantic and Pacific Oceans to fill the vacant space, the subsequent recoil of enormous waves, which would traverse both these oceans and produce myriads of changes along their shores, the corresponding atmospheric waves complicated by the currents surrounding each volcanic vent, and the electrical discharges with which such disturbances are accompanied. But these temporary effects would be insignificant compared with the permanent ones. The currents of the Atlantic and Pacific would be altered in their directions and amounts. The distribution of heat achieved by these ocean currents would be different from what it is. The arrangement of the isothermal lines, not only on neighbouring continents, but even throughout Europe, would be changed. The tides would flow differently from what they do now. There would be more or less modification of the winds in their periods, strengths, directions, qualities. Rain would fall scarcely anywhere at the same times and in the same quantities as at present. In short, the meteorological conditions thousands of miles off, on all sides, would be more or less revolutionized. Thus, without taking into account the infinitude of modifications which these changes would produce upon the flora and fauna, both of land and sea, the reader will perceive the immense heterogeneity of the results wrought out by one force, when that force expends itself upon a previously complicated area; and he will draw the corollary that from the beginning the complication has advanced at an increasing rate.

Before going on to show how organic progress also depends on the law that every force produces more than one change, we have to notice the manifestation of this law in yet another species of inorganic progress—namely,

chemical. The same general causes that have wrought out the heterogeneity of the Earth, physically considered, have simultaneously wrought out its chemical heterogeneity. There is every reason to believe that at an extreme heat the elements cannot combine. Even under such heat as can be artificially produced, some very strong affinities yield, as, for instance, that of oxygen for hydrogen; and the great majority of chemical compounds are decomposed at much lower temperatures. But without insisting on the highly probable inference, that when the Earth was in its first state of incandescence there were no chemical combinations at all, it will suffice for our purpose to point to the unquestionable fact that the compounds which can exist at the highest temperatures, and which must, therefore, have been the first that were formed as the Earth cooled, are those of the simplest constitutions. The protoxides—including under that head the alkalis, earths, &c.—are, as a class, the most stable compounds we know: most of them resisting decomposition by any heat we can generate. These are combinations of the simplest order—are but one degree less homogeneous than the elements themselves. More heterogeneous, less stable, and therefore later in the Earth's history, are the deutoxides, tritoxides, peroxides, &c.; in which two, three, four, or more atoms of oxygen are united with one atom of metal or other element. Higher than these in heterogeneity are the hydrates; in which an oxide of hydrogen, united with an oxide of some other element, forms a substance whose atoms severally contain at least four ultimate atoms of three different kinds. Yet more heterogeneous and less stable still are the salts; which present us with molecules each made up of five, six, seven, eight, ten, twelve, or more atoms, of three, if not more, kinds. Then there are the hydrated salts, of a yet greater heterogeneity, which undergo partial decomposition at much lower temperatures. After them come the further complicated supersalts and double

salts, having a stability again decreased ; and so throughout. Without entering into qualifications for which space fails, we believe no chemist will deny it to be a general law of these inorganic combinations that, *other things equal*, the stability decreases as the complexity increases. When we pass to the compounds of organic chemistry, we find this general law still further exemplified : we find much greater complexity and much less stability. A molecule of albumen, for instance, consists of 482 ultimate atoms of five different kinds. Fibrine, still more intricate in constitution, contains in each molecule, 298 atoms of carbon, 49 of nitrogen, 2 of sulphur, 228 of hydrogen, and 92 of oxygen—in all, 669 atoms ; or, more strictly speaking, equivalents. And these two substances are so unstable as to decompose at quite ordinary temperatures ; as that to which the outside of a joint of roast meat is exposed. Thus it is manifest that the present chemical heterogeneity of the Earth's surface has arisen by degrees, as the decrease of heat has permitted ; and that it has shown itself in three forms—first, in the multiplication of chemical compounds ; second, in the greater number of different elements contained in the more modern of these compounds ; and third, in the higher and more varied multiples in which these more numerous elements combine.

To say that this advance in chemical heterogeneity is due to the one cause, diminution of the Earth's temperature, would be to say too much ; for it is clear that aqueous and atmospheric agencies have been concerned ; and further, that the affinities of the elements themselves are implied. The cause has all along been a composite one : the cooling of the Earth having been simply the most general of the concurrent causes, or assemblage of conditions. And here, indeed, it may be remarked that in the several classes of facts already dealt with (excepting, perhaps, the first), and still more in those with which we shall presently deal, the causes are more or less compound ; as indeed are

nearly all causes with which we are acquainted. Scarcely any change can rightly be ascribed to one agency alone, to the neglect of the permanent or temporary conditions under which only this agency produces the change. But as it does not materially affect our argument, we prefer, for simplicity's sake, to use throughout the popular mode of expression. Perhaps it will be further objected, that to assign loss of heat as the cause of any changes, is to attribute these changes not to a force, but to the absence of a force. And this is true. Strictly speaking, the changes should be attributed to those forces which come into action when the antagonist force is withdrawn. But though there is inaccuracy in saying that the freezing of water is due to the loss of its heat, no practical error arises from it; nor will a parallel laxity of expression vitiate our statements respecting the multiplication of effects. Indeed, the objection serves but to draw attention to the fact, that not only does the exertion of a force produce more than one change, but the withdrawal of a force produces more than one change.

Returning to the thread of our exposition, we have next to trace, throughout organic progress, this same all-pervading principle. And here, where the evolution of the homogeneous into the heterogeneous was first observed, the production of many effects by one cause is least easy to demonstrate. The development of a seed into a plant, or an ovum into an animal, is so gradual, while the forces which determine it are so involved, and at the same time so unobtrusive, that it is difficult to detect the multiplication of effects which is elsewhere so obvious. But, guided by indirect evidence, we may safely conclude that here too the law holds. Note, first, how numerous are the changes which any marked action works upon an adult organism—a human being, for instance. An alarming sound or sight, besides the impressions on the organs of sense and the nerves, may produce a start, a scream, a

distortion of the face, a trembling consequent on general muscular relaxation, a burst of perspiration, a rush of blood to the brain, followed possibly by arrest of the heart's action and by syncope; and if the subject be feeble, an indisposition with its long train of complicated symptoms may set in. Similarly in cases of disease. A minute portion of the small-pox virus introduced into the system, will, in a severe case, cause, during the first stage, rigors, heat of skin, accelerated pulse, furred tongue, loss of appetite, thirst, epigastric uneasiness, vomiting, headache, pains in the back and limbs, muscular weakness, convulsions, delirium, &c.; in the second stage, cutaneous eruption, itching, tingling, sore throat, swelled fauces, salivation, cough, hoarseness, dyspnœa, &c.; and in the third stage, œdematous inflammations, pneumonia, pleurisy, diarrhœa, inflammation of the brain, ophthalmia, erysipelas, &c.: each of which enumerated symptoms is itself more or less complex. Medicines, special foods, better air, might in like manner be instanced as producing multiplied results. Now it needs only to consider that the many changes thus wrought by one force upon an adult organism, will be in part paralleled in an embryo organism, to understand how here also, the evolution of the homogeneous into the heterogeneous may be due to the production of many effects by one cause. The external heat, which, falling on a matter having special proclivities, determines the first complications of the germ, may, by acting on these, superinduce further complications; upon these still higher and more numerous ones; and so on continually: each organ as it is developed serving, by its actions and reactions on the rest, to initiate new complexities. The first pulsations of the foetal heart must simultaneously aid the unfolding of every part. The growth of each tissue, by taking from the blood special proportions of elements, must modify the constitution of the blood; and so must modify the nutrition of all the other tissues. The heart's action,

implying as it does a certain waste, necessitates an addition to the blood of effete matters, which must influence the rest of the system, and perhaps, as some think, cause the formation of excretory organs. The nervous connexions established among the viscera must further multiply their mutual influences; and so continually. Still stronger becomes the probability of this view when we call to mind the fact, that the same germ may be evolved into different forms according to circumstances. Thus, during its earlier stages, every embryo is sexless—becomes either male or female as the balance of forces acting on it determines. Again, it is a well-established fact that the larva of a working-bee will develop into a queen-bee, if before it is too late, its food be changed to that on which the larvæ of queen-bees are fed. All which instances suggest that the proximate cause of each advance in embryonic complication is the action of incident forces upon the complication previously existing. Indeed, we may find *a priori* reason to think that the evolution proceeds after this manner. For since no germ, animal or vegetal, contains the slightest rudiment or indication of the future organism—since the microscope has shown us that the first process set up in every fertilized germ, is a process of repeated spontaneous fissions ending in the production of a mass of cells, not one of which exhibits any special character; there seems no alternative but to suppose that the partial organization at any moment existing in a growing embryo, is transformed by the agencies acting upon it into the succeeding phase of organization, and this into the next, until, through ever-increasing complexities, the ultimate form is reached. Not indeed that we can thus really explain the production of any plant or animal. We are still in the dark respecting those mysterious properties in virtue of which the germ, when subject to fit influences, undergoes the special changes that begin the series of transformations. All we aim to show, is, that given a germ possessing those

particular proclivities distinguishing the species to which it belongs, and the evolution of an organism from it, probably depends on that multiplication of effects which we have seen to be the cause of progress in general, so far as we have yet traced it.

When, leaving the development of single plants and animals, we pass to that of the Earth's flora and fauna, the course of our argument again becomes clear and simple. Though, as was admitted in the first part of this article, the fragmentary facts Paleontology has accumulated, do not clearly warrant us in saying that, in the lapse of geologic time, there have been evolved more heterogeneous organisms, and more heterogeneous assemblages of organisms, yet we shall now see that there *must* ever have been a tendency towards these results. We shall find that the production of many effects by one cause, which as already shown, has been all along increasing the physical heterogeneity of the Earth, has further involved an increasing heterogeneity in its flora and fauna, individually and collectively. An illustration will make this clear. Suppose that by a series of upheavals, occurring, as they are now known to do, at long intervals, the East Indian Archipelago were to be, step by step, raised into a continent, and a chain of mountains formed along the axis of elevation. By the first of these upheavals, the plants and animals inhabiting Borneo, Sumatra, New Guinea, and the rest, would be subjected to slightly modified sets of conditions. The climate in general would be altered in temperature, in humidity, and in its periodical variations; while the local differences would be multiplied. These modifications would affect, perhaps inappreciably, the entire flora and fauna of the region. The change of level would produce additional modifications: varying in different species, and also in different members of the same species, according to their distance from the axis of elevation. Plants, growing only on the sea-shore in special localities, might become extinct.

Others, living only in swamps of a certain humidity, would, if they survived at all, probably undergo visible changes of appearance. While still greater alterations would occur in the plants gradually spreading over the lands newly raised above the sea. The animals and insects living on these modified plants, would themselves be in some degree modified by change of food, as well as by change of climate; and the modification would be more marked where, from the dwindling or disappearance of one kind of plant, an allied kind was eaten. In the lapse of the many generations arising before the next upheaval, the sensible or insensible alterations thus produced in each species would become organized—there would be a more or less complete adaptation to the new conditions. The next upheaval would superinduce further organic changes, implying wider divergences from the primary forms; and so repeatedly. But now let it be observed that the revolution thus resulting would not be a substitution of a thousand more or less modified species for the thousand original species; but in place of the thousand original species there would arise several thousand species, or varieties, or changed forms. Each species being distributed over an area of some extent, and tending continually to colonize the new area exposed, its different members would be subject to different sets of changes. Plants and animals spreading towards the equator would not be affected in the same way as others spreading from it. Those spreading towards the new shores would undergo changes unlike the changes undergone by those spreading into the mountains. Thus, each original race of organisms, would become the root from which diverged several races differing more or less from it and from each other; and while some of these might subsequently disappear, probably more than one would survive in the next geologic period: the very dispersion itself increasing the chances of survival. Not only would there be certain modifications thus caused by change of physical conditions and food, but also in some

cases other modifications caused by change of habit. The fauna of each island, peopling, step by step, the newly-raised tracts, would eventually come in contact with the faunas of other islands; and some members of these other faunas would be unlike any creatures beforeseen. Herbivores meeting with new beasts of prey, would, in some cases, be led into modes of defence or escape differing from those previously used; and simultaneously the beasts of prey would modify their modes of pursuit and attack. We know that when circumstances demand it, such changes of habit *do* take place in animals; and we know that if the new habits become the dominant ones, they must eventually in some degree alter the organization. Observe now, however, a further consequence. There must arise not simply a tendency towards the differentiation of each race of organisms into several races; but also a tendency to the occasional production of a somewhat higher organism. Taken in the mass these divergent varieties which have been caused by fresh physical conditions and habits of life, will exhibit changes quite indefinite in kind and degree; and changes that do not necessarily constitute an advance. Probably in most cases the modified type will be neither more nor less heterogeneous than the original one. In some cases the habits of life adopted being simpler than before, a less heterogeneous structure will result: there will be a retrogradation. But it *must* now and then occur, that some division of a species, falling into circumstances which give it rather more complex experiences, and demand actions somewhat more involved, will have certain of its organs further differentiated in proportionately small degrees,—will become slightly more heterogeneous. Thus, in the natural course of things, there will from time to time arise an increased heterogeneity both of the Earth's flora and fauna, and of individual races included in them. Omitting detailed explanations, and allowing for the qualifications which cannot here be specified, we think it is clear that

geological mutations have all along tended to complicate the forms of life, whether regarded separately or collectively. The same causes which have led to the evolution of the Earth's crust from the simple into the complex, have simultaneously led to a parallel evolution of the Life upon its surface. In this case, as in previous ones, we see that the transformation of the homogeneous into the heterogeneous is consequent upon the universal principle, that every active force produces more than one change.

The deduction here drawn from the established truths of geology and the general laws of life, gains immensely in weight on finding it to be in harmony with an induction drawn from direct experience. Just that divergence of many races from one race, which we inferred must have been continually occurring during geologic time, we know to have occurred during the pre-historic and historic periods, in man and domestic animals. And just that multiplication of effects which we concluded must have produced the first, we see has produced the last. Single causes, as famine, pressure of population, war, have periodically led to further dispersions of mankind and of dependent creatures: each such dispersion initiating new modifications, new varieties of type. Whether all the human races be or be not derived from one stock, philology makes it clear that whole groups of races now easily distinguishable from each other, were originally one race,—that the diffusion of one race into different climates and conditions of existence, has produced many modified forms of it. Similarly with domestic animals. Though in some cases—as that of dogs—community of origin will perhaps be disputed, yet in other cases—as that of the sheep or the cattle of our own country—it will not be questioned that local differences of climate, food, and treatment, have transformed one original breed into numerous breeds now become so far distinct as to produce unstable hybrids. Moreover, through the complication of

effects flowing from single causes, we here find, what we before inferred, not only an increase of general heterogeneity, but also of special heterogeneity. While of the divergent divisions and subdivisions of the human race many have undergone changes not constituting an advance; while in some the type may have degraded; in others it has become decidedly more heterogeneous. The civilized European departs more widely from the vertebrate archetype than does the savage. Thus, both the law and the cause of progress, which, from lack of evidence, can be but hypothetically substantiated in respect of the earlier forms of life on our globe, can be actually substantiated in respect of the latest forms.*

If the advance of Man towards greater heterogeneity is traceable to the production of many effects by one cause, still more clearly may the advance of Society towards greater heterogeneity be so explained. Consider the growth of an industrial organization. When, as must occasionally happen, some member of a tribe displays unusual aptitude for making an article of general use—a weapon, for instance—which was before made by each man for himself, there arises a tendency towards the

* The argument concerning organic evolution contained in this paragraph and the one preceding it, stands verbatim as it did when first published in the *Westminster Review* for April, 1857. I have thus left it without the alteration of a word that it may show the view I then held concerning the origin of species. The sole cause recognized is that of direct adaptation of constitution to conditions consequent on inheritance of the modifications of structure resulting from use and disuse. There is no recognition of that further cause disclosed in Mr. Darwin's work, published two and a half years later—the indirect adaptation resulting from the natural selection of favourable variations. The multiplication of effects is, however, equally illustrated in whatever way the adaptation to changing conditions is effected, or if it is effected in both ways, as I hold. I may add that there is indicated the view that the succession of organic forms is not serial but proceeds by perpetual divergence and re-divergence—that there has been a continual “divergence of many races from one race”: each species being a “root” from which several other species branch out; and the growth of a tree being thus the implied symbol.

differentiation of that member into a maker of such weapon. His companions—warriors and hunters all of them,—severally feel the importance of having the best weapons that can be made; and are therefore certain to offer strong inducements to this skilled individual to make weapons for them. He, on the other hand, having not only an unusual faculty, but an unusual liking, for making such weapons (the talent and the desire for any occupation being commonly associated), is predisposed to fulfil each commission on the offer of an adequate reward: especially as his love of distinction is also gratified and his living facilitated. This first specialization of function, once commenced, tends ever to become more decided. On the side of the weapon-maker practice gives increased skill—increased superiority to his products. On the side of his clients, cessation of practice entails decreased skill. Thus the influences which determine this division of labour grow stronger in both ways; and the incipient heterogeneity is, on the average of cases, likely to become permanent for that generation if no longer. This process not only differentiates the social mass into two parts, the one monopolizing, or almost monopolizing, the performance of a certain function, and the other losing the habit, and in some measure the power, of performing that function; but it tends to initiate other differentiations. The advance described implies the introduction of barter,—the maker of weapons has, on each occasion, to be paid in such other articles as he agrees to take in exchange. He will not habitually take in exchange one kind of article, but many kinds. He does not want mats only, or skins, or fishing-gear, but he wants all these, and on each occasion will bargain for the particular things he most needs. What follows? If among his fellows there exist any slight differences of skill in the manufacture of these various things, as there are almost sure to do, the weapon-maker will take from each one the thing which that one excels in making: he will exchange for mats with him

whose mats are superior, and will bargain for the fishing-gear of him who has the best. But he who has bartered away his mats or his fishing-gear, must make other mats or fishing-gear for himself; and in so doing must, in some degree, further develop his aptitude. Thus it results that the small specialities of faculty possessed by various members of the tribe, will tend to grow more decided. And whether or not there ensue distinct differentiations of other individuals into makers of particular articles, it is clear that incipient differentiations take place throughout the tribe: the one original cause produces not only the first dual effect, but a number of secondary dual effects, like in kind, but minor in degree. This process, of which traces may be seen among schoolboys, cannot well produce lasting effects in an unsettled tribe; but where there grows up a fixed and multiplying community, such differentiations become permanent, and increase with each generation. The enhanced demand for every commodity, intensifies the functional activity of each specialized person or class; and this renders the specialization more definite where it already exists, and establishes it where it is but nascent. By increasing the pressure on the means of subsistence, a larger population again augments these results; seeing that each person is forced more and more to confine himself to that which he can do best, and by which he can gain most. Presently, under these same stimuli, new occupations arise. Competing workers, ever aiming to produce improved articles, occasionally discover better processes or raw materials. The substitution of bronze for stone entails on him who first makes it a great increase of demand; so that he or his successor eventually finds all his time occupied in making the bronze for the articles he sells, and is obliged to depute the fashioning of these articles to others; and, eventually, the making of bronze, thus differentiated from a pre-existing occupation, becomes an occupation by itself. But now mark the ramified changes which follow this

change. Bronze presently replaces stone, not only in the articles it was first used for, but in many others—in arms, tools, and utensils of various kinds : and so affects the manufacture of them. Further, it affects the processes which these utensils subserve, and the resulting products, —modifies buildings, carvings, personal decorations. Yet again, it sets going manufactures which were before impossible, from lack of a material fit for the requisite implements. And all these changes react on the people—increase their manipulative skill, their intelligence, their comfort,—refine their habits and tastes. Thus the evolution of a homogeneous society into a heterogeneous one, is clearly consequent on the general principle, that many effects are produced by one cause.

Space permitting, we might show how the localization of special industries in special parts of a kingdom, as well as the minute subdivision of labour in the making of each commodity, are similarly determined. Or, turning to a somewhat different order of illustrations, we might dwell on the multitudinous changes—material, intellectual, moral,—caused by printing; or the further extensive series of changes wrought by gunpowder. But leaving the intermediate phases of social development, let us take a few illustrations from its most recent and its passing phases. To trace the effects of steam-power, in its manifold applications to mining, navigation, and manufactures of all kinds, would carry us into unmanageable detail. Let us confine ourselves to the latest embodiment of steam power—the locomotive engine. This, as the proximate cause of our railway system, has changed the face of the country, the course of trade, and the habits of the people. Consider, first, the complicated sets of changes that precede the making of every railway—the provisional arrangements, the meetings, the registration, the trial section, the parliamentary survey, the lithographed plans, the books of reference, the local deposits and notices, the application to

Parliament, the passing Standing Orders Committee, the first, second, and third readings : each of which brief heads indicates a multiplicity of transactions, and the extra development of sundry occupations—as those of engineers, surveyors, lithographers, parliamentary agents, share-brokers ; and the creation of sundry others—as those of traffic-takers, reference-takers. Consider, next, the yet more marked changes implied in railway construction—the cuttings, embankings, tunnellings, diversions of roads ; the building of bridges and stations, the laying down of ballast, sleepers, and rails ; the making of engines, tenders, carriages, and waggons : which processes, acting on numerous trades, increase the importation of timber, the quarrying of stone, the manufacture of iron, the mining of coal, the burning of bricks ; institute a variety of special manufactures weekly advertised in the *Railway Times* ; and, finally, open the way to sundry new occupations, as those of drivers, stokers, cleaners, plate-layers, &c., &c. And then consider the changes, still more numerous and involved, which railways in action produce on the community at large. Business agencies are established where previously they would not have paid ; goods are obtained from remote wholesale houses instead of near retail ones ; and commodities are used which distance once rendered inaccessible. Again, the diminished cost of carriage tends to specialize more than ever the industries of different districts—to confine each manufacture to the parts in which, from local advantages, it can be best carried on. Further, the fall in freights, facilitating distribution, equalizes prices, and also, on the average, lowers prices : thus bringing divers articles within the means of those before unable to buy them, and so increasing their comforts and improving their habits. At the same time the practice of travelling is immensely extended. People who never before dreamed of it, take trips to the sea ; visit their distant relations ; make tours ; and so we

are benefited in body, feelings, and ideas. The more prompt transmission of letters and of news produces other marked changes—makes the pulse of the nation faster. Once more, there arises a wide dissemination of cheap literature through railway book-stalls, and of advertisements in railway carriages: both of them aiding ulterior progress. And the countless changes here briefly indicated are consequent on the invention of the locomotive engine. The social organism has been rendered more heterogeneous in virtue of the many new occupations introduced, and the many old ones further specialized; prices of nearly all things in every place have been altered; each trader has modified his way of doing business; and every person has been affected in his actions, thoughts, emotions.

Illustrations to the same effect might be indefinitely accumulated, but they are needless. The only further fact demanding notice, is, that we here see still more clearly the truth before pointed out, that in proportion as the area on which any force expends itself becomes heterogeneous, the results are in a yet higher degree multiplied in number and kind. While among the simple tribes to whom it was first known, caoutchouc caused but few changes, among ourselves the changes have been so many and varied that the history of them occupies a volume.* Upon the small, homogeneous community inhabiting one of the Hebrides, the electric telegraph would produce, were it used, scarcely any results; but in England the results it produces are multitudinous. The comparatively simple organization under which our ancestors lived five centuries ago, could have undergone but few modifications from an event like the recent one at Canton; but now, the legislative decision respecting it sets up many hundreds of complex modifications, each of which will be the parent of numerous future ones.

Space permitting, we could willingly have pursued the

* "Personal Narrative of the Origin of the Caoutchouc, or India-Rubber Manufacture in England." By Thomas Hancock.

argument in relation to all the subtler results of civilization. As before we showed that the law of progress to which the organic and inorganic worlds conform, is also conformed to by Language, the plastic arts, Music, &c. ; so might we here show that the cause which we have hitherto found to determine progress holds in these cases also. Instances might be given proving how, in Science, an advance of one division presently advances other divisions—how Astronomy has been immensely forwarded by discoveries in Optics, while other optical discoveries have initiated Microscopic Anatomy, and greatly aided the growth of Physiology—how Chemistry has indirectly increased our knowledge of Electricity, Magnetism, Biology, Geology—how Electricity has reacted on Chemistry and Magnetism, and has developed our views of Light and Heat. In Literature the same truth might be exhibited in the manifold effects of the primitive mystery-play, as originating the modern drama, which has variously branched; or in the still multiplying forms of periodical literature which have descended from the first newspaper, and which have severally acted and reacted on other forms of literature and on each other. The influence which a new school of Painting—as that of the pre-Raphaelites—exercises upon other schools; the hints which all kinds of pictorial art are deriving from Photography; the complex results of new critical doctrines, as those of Mr. Ruskin, might severally be dwelt upon as displaying the like multiplication of effects.

But we venture to think our case is already made out. The imperfections of statement which brevity has necessitated, do not, we believe, invalidate the propositions laid down. The qualifications here and there demanded would not, if made, affect the inferences. Though, in tracing the genesis of progress, we have frequently spoken of complex causes as if they were simple ones; it still remains true that such causes are far less complex than their results. Detailed criticisms do not affect our main position. Endless

facts go to show that every kind of progress is from the homogeneous to the heterogeneous; and that it is so because each change is followed by many changes. And it is significant that where the facts are most accessible and abundant, there these truths are most manifest.

However, to avoid committing ourselves to more than is yet proved, we must be content with saying that such are the law and the cause of all progress that is known to us. Should the Nebular Hypothesis ever be established, then it will become manifest that the Universe at large, like every organism, was once homogeneous; that as a whole, and in every detail, it has unceasingly advanced towards greater heterogeneity. It will be seen that as in each event of to-day, so from the beginning, the decomposition of every expended force into several forces has been perpetually producing a higher complication; that the increase of heterogeneity so brought about is still going on and must continue to go on; and that thus progress is not an accident, not a thing within human control, but a beneficent necessity.

A few words must be added on the ontological bearings of our argument. Probably not a few will conclude that here is an attempted solution of the great questions with which Philosophy in all ages has perplexed itself. Let none thus deceive themselves. After all that has been said, the ultimate mystery remains just as it was. The explanation of that which is explicable, does but bring out into greater clearness the inexplicableness of that which remains behind. Little as it seems to do so, fearless inquiry tends continually to give a firmer basis to all true Religion. The timid sectarian, obliged to abandon one by one the superstitions bequeathed to him, and daily finding his cherished beliefs more and more shaken, secretly fears that all things may some day be explained; and has a corresponding dread of Science: thus evincing the pro-

foundest of all infidelity—the fear lest the truth be bad. On the other hand, the sincere man of science, content to follow wherever the evidence leads him, becomes by each new inquiry more profoundly convinced that the Universe is an insoluble problem. Alike in the external and the internal worlds, he sees himself in the midst of ceaseless changes, of which he can discover neither beginning nor end. If, tracing back the evolution of things, he allows himself to entertain the hypothesis that all matter once existed in a diffused form, he finds it impossible to conceive how this came to be so; and equally, if he speculates on the future, he can assign no limit to the grand succession of phenomena ever unfolding themselves before him. Similarly, if he looks inward, he perceives that both terminations of the thread of consciousness are beyond his grasp: he cannot remember when or how consciousness commenced, and he cannot examine the consciousness at any moment existing; for only a state of consciousness which is already past can become the object of thought, and never one which is passing. When, again, he turns from the succession of phenomena, external or internal, to their essential nature, he is equally at fault. Though he may succeed in resolving all properties of objects into manifestations of force, he is not thereby enabled to conceive what force is; but finds, on the contrary, that the more he thinks about it, the more he is baffled. Similarly, though analysis of mental actions may finally bring him down to sensations as the original materials out of which all thought is woven, he is none the forwarder; for he cannot in the least comprehend sensation. Inward and outward things he thus discovers to be alike inscrutable in their ultimate genesis and nature. He sees that the Materialist and Spiritualist controversy is a mere war of words; the disputants being equally absurd—each believing he understands that which it is impossible for any man to understand. In all directions his investigations even-

tually bring him face to face with the unknowable; and he ever more clearly perceives it to be the unknowable. He learns at once the greatness and the littleness of human intellect—its power in dealing with all that comes within the range of experience; its impotence in dealing with all that transcends experience. He feels more vividly than any others can feel, the utter incomprehensibleness of the simplest fact, considered in itself. He alone truly *sees* that absolute knowledge is impossible. He alone *knows* that under all things there lies an impenetrable mystery.